CLAIMS

What is claimed is:

1. A digital baseband (DBB) transmitter comprising:

(a) an analog radio transmitter;

(b) a plurality of digital compensation modules;

(c) at least one digital to analog converter (DAC) for interfacing the digital compensation modules with the analog radio transmitter; and

(d) at least one controller in communication with the analog radio transmitter and each of the digital compensation modules, wherein the digital compensation modules correct radio frequency (RF) parameter deficiencies that occur in the analog radio transmitter.

2. The DBB transmitter of claim 1 wherein the analog radio transmitter comprises:

(i) a power amplifier;

(ii) a modulator; and

(iii) a power detector.

3. The DBB transmitter of claim 2 wherein the analog radio transmitter further comprises a temperature sensor for monitoring a temperature reading associated with the analog radio transmitter, and at least one of the digital compensation modules is activated in response to the temperature sensor.

4. The DBB transmitter of claim 2 wherein the analog radio transmitter further comprises a bias current sensor for monitoring a bias current reading associated with the analog radio transmitter, and at least one of the digital compensation modules is activated in response to the bias current sensor.

5. The DBB transmitter of claim 4 wherein the digital compensation modules include a digital pre-distortion compensation module, the DBB transmitter further comprising:

(e) a memory for storing a plurality of look up tables (LUTs), wherein one of the LUTs is selected for use by the digital pre-distortion compensation module in response to the temperature reading monitored by the temperature sensor.

6. The DBB transmitter of claim 5 wherein the digital compensation modules include a digital pre-distortion compensation module having two signal inputs including an in-phase (I) signal component and a quadrature (Q) signal component, the power amplifier is prone to a linearity deficiency, and the digital pre-distortion compensation module is configured to distort the phase and amplitude of the I and Q signal components based on gain and phase characteristics of the power amplifier stored in the selected LUT, such that the power amplifier generates a linear response rather than a distorted response.

7. The DBB transmitter of claim 1 wherein the digital compensation modules include a digital pre-distortion compensation module having two signal inputs including an in-phase (I) input and a quadrature (Q) input, the DBB transmitter further comprising:

(e) a low pass filter (LPF) coupled to each of the I and Q inputs of the digital pre-distortion compensation module.

8. The DBB transmitter of claim 7 wherein each LPF is a root-raised cosine (RRC) filter.

9. The DBB transmitter of claim 1 wherein the digital compensation modules include a digital direct current (DC) offset compensation module having two signal inputs including an in-phase (I) signal component and a quadrature (Q) signal

component, the analog radio transmitter includes a modulator prone to a carrier leakage deficiency, a minimum detected reading associated with each of the signal inputs is determined, first and second DC offset compensation values are determined based on the minimum detected readings, and the digital DC offset compensation module is configured to eliminate carrier leakage associated with the modulator by adjusting the respective DC levels of the two signal inputs based on the first and second DC offset compensation values.

10. The DBB transmitter of claim 9 wherein the modulator has a local oscillator (LO) frequency at which the minimum detected readings are determined.

11. The DBB transmitter of claim 1 wherein the digital compensation modules include a digital amplitude imbalance compensation module having two signal inputs including an in-phase (I) signal component and a quadrature (Q) signal component, the analog radio transmitter includes a modulator prone to an amplitude balance deficiency, and the digital amplitude imbalance compensation module is configured to adjust the power level of one of the I and Q signal components, such that the power level of each of the I and Q signal components is the same.

12. The DBB transmitter of claim 1 wherein the digital compensation modules include a digital phase imbalance compensation module having two signal inputs including an in-phase (I) signal component and a quadrature (Q) signal component, the analog radio transmitter includes a modulator prone to a phase balance deficiency, and the digital phase imbalance compensation module is configured to adjust the phase of the I and Q signal components, such that the phase of each of the I and Q signal components are orthogonal to each other.

13. The DBB transmitter of claim 1 further comprising:

(e) a modem for generating in-phase (I) and quadrature (Q) signal components which are input to each of the digital compensation modules, the DAC and the analog radio transmitter.

14. A wireless transmit/receive unit (WTRU) comprising:

(a) an analog radio transmitter;

(b) a plurality of digital compensation modules;

(c) at least one digital to analog converter (DAC) for interfacing the digital compensation modules with the analog radio transmitter; and

(d) at least one controller in communication with the analog radio transmitter and each of the digital compensation modules, wherein the digital compensation modules correct radio frequency (RF) parameter deficiencies that occur in the analog radio transmitter.

15. The WTRU of claim 14 wherein the analog radio transmitter comprises:

(i) a power amplifier;

(ii) a modulator; and

(iii) a power detector.

16. The WTRU of claim 15 wherein the analog radio transmitter further comprises a temperature sensor for monitoring a temperature reading associated with the analog radio transmitter, and at least one of the digital compensation modules is activated in response to the temperature sensor.

17. The WTRU of claim 15 wherein the analog radio transmitter further comprises a bias current sensor for monitoring a bias current reading associated with the analog radio transmitter, and at least one of the digital compensation modules is activated in response to the bias current sensor.

18. The WTRU of claim 17 wherein the digital compensation modules include a digital pre-distortion compensation module, the WTRU further comprising:

(e) a memory for storing a plurality of look up tables (LUTs), wherein one of the LUTs is selected for use by the digital pre-distortion compensation module in response to the temperature reading monitored by the temperature sensor.

19. The WTRU of claim 18 wherein the digital compensation modules include a digital pre-distortion compensation module having two signal inputs including an in-phase (I) signal component and a quadrature (Q) signal component, the power amplifier is prone to a linearity deficiency, and the digital pre-distortion compensation module is configured to distort the phase and amplitude of the I and Q signal components based on the gain and phase characteristics of the power amplifier stored in the selected LUT, such that the power amplifier generates a linear response rather than a distorted response.

20. The WTRU of claim 14 wherein the digital compensation modules include a digital pre-distortion compensation module having two signal inputs including an in-phase (I) input and a quadrature (Q) input, the WTRU further comprising:

(e) a low pass filter (LPF) coupled to each of the I and Q inputs of the digital pre-distortion compensation module.

21. The WTRU of claim 20 wherein each LPF is a root-raised cosine (RRC) filter.

22. The WTRU of claim 14 wherein the digital compensation modules include a digital DC offset compensation module having two signal inputs including an in-phase (I) signal component and a quadrature (Q) signal component, the analog radio transmitter includes a modulator prone to a carrier leakage deficiency, a minimum detected reading associated with each of the signal inputs is determined, first and

second DC offset compensation values are determined based on the minimum detected readings, and the digital DC offset compensation module is configured to eliminate carrier leakage associated with the modulator by adjusting the respective DC levels of the two signal inputs based on the first and second DC offset compensation values.

23. The WTRU of claim 22 wherein the modulator has a local oscillator (LO) frequency at which the minimum detected readings are determined.

24. The WTRU of claim 14 wherein the digital compensation modules include a digital amplitude imbalance compensation module having two signal inputs including an in-phase (I) signal component and a quadrature (Q) signal component, the analog radio transmitter includes a modulator prone to an amplitude balance deficiency, and the digital amplitude imbalance compensation module is configured to adjust the power level of one of the I and Q signal components, such that the power level of each of the I and Q signal components is the same.

25. The WTRU of claim 14 wherein the digital compensation modules include a digital phase imbalance compensation module having two signal inputs including an in-phase (I) signal component and a quadrature (Q) signal component, the analog radio transmitter includes a modulator prone to a phase balance deficiency, and the digital phase imbalance compensation module is configured to adjust the phase of the I and Q signal components, such that the phase of each of the I and Q signal components are orthogonal to each other.

26. The WTRU of claim 14 further comprising:

(e) a modem for generating in-phase (I) and quadrature (Q) signal components which are input to each of the digital compensation modules, the DAC and the analog radio transmitter.

27. In a digital baseband (DBB) transmitter including a modem for generating in-phase (I) and quadrature (Q) signal components, a digital pre-distortion compensation module and an analog radio transmitter having a bias current sensor and a temperature sensor, a method of correcting radio frequency (RF) parameter deficiencies that exist in the analog radio transmitter, the method comprising:

(a) selecting and initializing a particular communication mode;

(b) the temperature sensor monitoring the temperature of one or more components of the analog radio transmitter;

(c) the bias current sensor monitoring the bias current of one or more components of the analog radio transmitter;

(d) selecting one of a plurality of look up tables (LUTs) from a memory based on at least one of the monitored temperature and the monitored bias current; and

(e) based on information in the selected LUT, distorting the phase and amplitude of the I and Q signal components such that an RF characteristic of at least one of the components in the analog radio transmitter is improved.

28. The method of claim 27 wherein the particular communication mode is one of time division duplex (TDD) and frequency division duplex (FDD).

29. In a digital baseband (DBB) transmitter including a modem for generating in-phase (I) and quadrature (Q) signal components, a digital direct current (DC) offset compensation module and an analog radio transmitter, a method of correcting radio frequency (RF) parameter deficiencies that exist in the analog radio transmitter, the method comprising:

(a) determining a first minimum detected reading associated with the Q signal component;

(b) determining a second minimum detected reading for the I signal component;

(c) determining first and second DC offset compensation values based on the first and second minimum detected readings;

(d) storing the first and second DC offset compensation values; and

(e) adjusting the DC levels of the I and Q signal components based on the stored first and second offset compensation values.

30. The method of claim 29 wherein the analog radio transmitter includes a modulator having a local oscillator (LO) frequency, the minimum detected readings are measured at the LO frequency, and the DC levels are adjusted to eliminate carrier leakage at the LO frequency.

31. In a digital baseband (DBB) transmitter including a modem for generating in-phase (I) and quadrature (Q) signal components, a digital amplitude imbalance compensation module and an analog radio transmitter, a method of correcting radio frequency (RF) parameter deficiencies that exist in the analog radio transmitter, the method comprising:

(a) deactivating the I signal component and determining a first power level of the Q signal component;

(b) activating the I signal component and deactivating the Q signal component, and determining a second power level of the I signal component; and

(c) adjusting the power level of one of the I and Q signal components such that the first and second power levels are the same.

32. In a digital baseband (DBB) transmitter including a modem for generating in-phase (I) and quadrature (Q) signal components, a digital phase imbalance compensation module and an analog radio transmitter, a method of correcting radio frequency (RF) parameter deficiencies that exist in the analog radio transmitter, the method comprising:

(a) reducing the power level of each of the I and Q signal components by a predetermined amount;

(b) measuring a power level of both of the I and Q signal components at the same time;

(c) determining the phase difference between the I and Q components by comparing the power level measured in step (b) with a previously determined reference power level; and

(d) if the phase difference is not zero, adjusting the phase difference such that the I and Q signal components are orthogonal to each other.

33. The method of claim 32 wherein the predetermined amount is 3 dB.

34. An integrated circuit (IC) for processing signals input to an analog radio transmitter, the IC comprising:

(a) a digital pre-distortion compensation module;

(b) a plurality of digital compensation modules;

(c) at least one digital to analog converter (DAC) for interfacing the digital compensation modules with the analog radio transmitter; and

(d) at least one controller in communication with the analog radio transmitter and each of the digital compensation modules, wherein the digital compensation modules correct radio frequency (RF) parameter deficiencies that occur in the analog radio transmitter.

35. The IC of claim 34 wherein the digital compensation modules include a digital pre-distortion compensation module, the IC further comprising:

(e) a memory for storing a plurality of look up tables (LUTs), wherein one of the LUTs is selected for use by the digital pre-distortion compensation module.

36. The IC of claim 35 wherein the digital pre-distortion compensation module has two signal inputs including an in-phase (I) signal component and a quadrature (Q) signal component, and the digital pre-distortion compensation module is configured to distort the phase and amplitude of the I and Q signal components based on information stored in the selected LUT, such that at least one RF characteristic of the analog radio transmitter is improved.

37. The IC of claim 34 wherein the digital compensation modules include a digital pre-distortion compensation module having two signal inputs including an in-phase (I) input and a quadrature (Q) input, the IC further comprising:

(e) a low pass filter (LPF) coupled to each of the I and Q inputs of the digital pre-distortion compensation module.

38. The IC of claim 37 wherein each LPF is a root-raised cosine (RRC) filter.

39. The IC of claim 34 wherein the digital compensation modules include a digital direct current (DC) offset compensation module having two signal inputs including an in-phase (I) signal component and a quadrature (Q) signal component, the analog radio transmitter includes a modulator prone to a carrier leakage deficiency, a minimum detected reading associated with each of the signal inputs is determined, first and second DC offset compensation values are determined based on the minimum detected readings, and the digital DC offset compensation module is configured to eliminate carrier leakage associated with the modulator by adjusting the respective DC levels of the two signal inputs based on the first and second DC offset compensation values.

40. The IC of claim 39 wherein the modulator has a local oscillator (LO) frequency at which the minimum detected readings are determined.

41. The IC of claim 34 wherein the digital compensation modules include a digital amplitude imbalance compensation module having two signal inputs including an in-phase (I) signal component and a quadrature (Q) signal component, the analog radio transmitter includes a modulator prone to an amplitude balance deficiency, and the digital amplitude imbalance compensation module is configured to adjust the power level of one of the I and Q signal components, such that the power level of each of the I and Q signal components is the same.

42. The IC of claim 34 wherein the digital compensation modules include a digital phase imbalance compensation module having two signal inputs including an in-phase (I) signal component and a quadrature (Q) signal component, the analog radio transmitter including a modulator prone to a phase balance deficiency, and the digital phase imbalance compensation module is configured to adjust the phase of the I and Q signal components, such that the phase of each of the I and Q signal components are orthogonal to each other.

43. The IC of claim 34 further comprising:

(e) a modem for generating in-phase (I) and quadrature (Q) signal components which are input to each of the digital compensation modules, the DAC and the analog radio transmitter.